DERWENT-ACC-NO: 1996-266672
DERWENT-WEEK: 199627

TITLE: Leak detector testing vacuum systems air-tightness - has body, heater
with dc source and thermal sensor in form of pyroelectric converter connected
to it and meter made as dc amplifier and differential amplifier

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PATENT-ASSIGNEE: GORELIK L L[GOREI]

PRIORITY-DATA: 1985SU-3973605 (October 31, 1985)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
SU 1342200 A1	October 20, 1995	N/A	003	G01M 003/16

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
SU 1342200A1	N/A	1985SU-3973605	October 31, 1985

INT-CL (IPC): G01M003/16

ABSTRACTED-PUB-NO: SU 1342200A
BASIC-ABSTRACT: The heater (2) is mounted in the body (1). The pyroelectric
converter (3) in the shape of a plate is mounted on the heat sink (4) through
the thermal insulation layer. The meter is in the form of a dc amplifier (6)
and a differential amplifier (9) connected to the amplifier (6) output through
the RC-circuits (7,8). The amplifier (9) has different input time constants.
The gas sample enters the body (1) and changes the gas thermal conductivity and
the heat flux temperature. The converter (3) ferroelectric

polarization moment
changes and the current pulse arrives at the amplifiers (6,9). The RC-circuits
eliminate the passage of the parasitic signals with a time constant greater
than the amplifier (9) time constant. The leak detector threshold sensitivity
is determined by the pyroelectric converter noise and heat flux fluctuations
caused by pressure and gas separation changes in the tested vacuum system.

USE/ADVANTAGE - Leak detector is used for testing air-tightness of vacuum
systems. Its sensitivity and reliability are

increased. Bul. 29/20.10.95

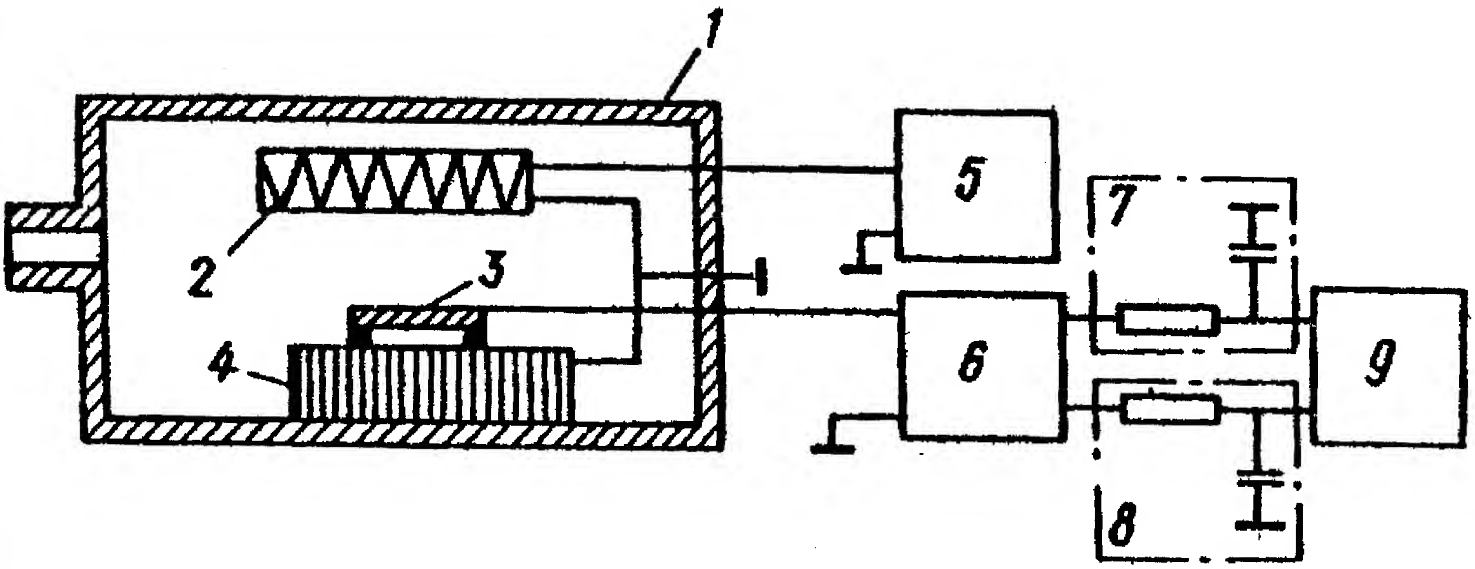
CHOSEN-DRAWING: Dwg.1/2

TITLE-TERMS:
LEAK DETECT TEST VACUUM SYSTEM AIR TIGHT BODY HEATER DC SOURCE THERMAL SENSE
FORM PYROELECTRIC CONVERTER CONNECT METER MADE DC AMPLIFY DIFFERENTIAL AMPLIFY

DERWENT-CLASS: S02

EPI-CODES: S02-J06A1;

SECONDARY-ACC-NO:
Non-CPI Secondary Accession Numbers: N1996-224290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TDB-ACC-NO: NN820669

DISCLOSURE TITLE: Pyroelectric Technique for Measurement of Thermal
Conductivity. June 1982.

PUBLICATION-DATA: IBM Technical Disclosure Bulletin, June 1982, US

VOLUME NUMBER: 25

ISSUE NUMBER: 1

PAGE NUMBER: 69 - 74

PUBLICATION-DATE: June 1, 1982 (19820601)

CROSS REFERENCE: 0018-8689-25-1-69

DISCLOSURE TEXT:

6p. Use is made of pyroelectric sensors to measure thermal
conductivity while avoiding the need for small temperature sensors
which are easily adapted to measurement of thin films and layers.
Other techniques do not appear to exist at room temperature.
- The progress of modern integrated circuit technology is limited
more by the removal of heat from chips and packages than by the
ability to construct densely packed circuits. In optimizing heat
removal, knowledge concerning the thermal properties of thin films
and layered structures is exceedingly important. Similarly in the
aerospace industry the thermal properties of paints, coatings and
layers are important. In developing new sources of energy (e.g.,
solar cells) as well as in more efficiently utilizing existing
sources, the thermal properties of thin sheets, layers,

coatings or
layered structures play an important role.

- Numerous techniques exist for measuring the thermal conductivity and diffusivity of bulk materials. These include steady-state, transient and thermal wave techniques. A thorough review of techniques for measurement of thermal conductivity and diffusivity as well as experimental data may be found in (*).

- In this article we describe how pyroelectric sensors can be used to measure the thermal properties, particularly the thermal diffusivity, of thin films, layers, etc. In Fig. 1A, we show an embodiment of our technique. Here, a thin layer of material 2 is in intimate thermal contact with a pyroelectric crystal or ceramic substrate 3 which has very thin conducting electrodes 4 on either side. The material 2 is heated by a short burst of energy 1, which is illustrated in Fig. 1B. As the heat absorbed in material 2 diffuses into the pyroelectric substrate 3, a charge is produced on the electrodes 4 which then flows through the load resistor (R(L)) 5 to create a voltage V at terminal 6 which is monitored on a suitable device, such as a digital oscilloscope or other transient recording media.

Fig. 2 shows a typical curve of voltage versus time recorded in this way by the pulse in Fig. 1B, both starting at time zero.
Analysis of the shape of this curve yields a value for the thermal diffusivity, alpha, of the sample where alpha=k/pC, where k is the thermal conductivity, p the density, and C the heat capacity of the sample. The amplitude of the curve or the area under

the curve gives
a value for the heat capacity.

- Although over-simplified when applied to the present case, the nature of the curve in Fig. 2 is understood from the solution to the thermal diffusion equation in one dimension (see original).

- As a function of time this equation is qualitatively of the same form as Fig. 2. The maximum temperature for fixed x occurs at t (max)= (max)=x/2/ /2 alpha. Interpreting x to be the thickness of the sample and alpha its to be thermal diffusivity, one sees that the curve scales as x2/2 alpha.

- Numerous experiments have been formed on thin thermally insulating films and layers at room temperature. These indicate that this scaling law is approximately obeyed and that, using the measured value of t(max) quite reasonable values of alpha are obtained.

Although the general nature of the curve in Fig. 2 is described by the above equation, and the x/2/ dependence has been confirmed and the values of alpha thereby found are reasonable, this is not meant as a quantitative analysis of the problem.

- A correct and detailed analysis of the voltage generated by the circuit of Fig. 1 in the presence of a sinusoidal energy input with absorption coefficient B, i.e., I=I(o)e/-Bx/e/1 omega t/ yields the following expression for the voltage V(omega) at the frequency omega (see original).

Here: (see original).

- The above equation of V(omega) accurately describes the device in the absence of thermal contact to the outside world. Heat loss to the surrounding media could be readily included in the equations if

deemed necessary.

- In order to describe a transient experiment with frequency components of the input heat described by I(0) (see original) I(0) (omega) y, correctly, the time dependent voltage is given by the inverse LaPlace transform of V (omega), i.e., (see original). where the above expression for V(omega) is used with i(0)(omega). Generally, the burst of heat will be chosen so that I(0)(omega) is independent of omega on the scale of interest (i.e., a delta function heat source). This expression for V(t) is in general non-trivial and will probably require a computer to do a quantitative fit to the data and thus obtain alpha(S) and C(S).

- Since experiment shows that the transient response scales as x/2/ /4 alpha t, it is clear that in order for I(t) to look like a delta function (i.e., I(omega) independent of omega), the heat pulse width delta t must obey delta T much less than x/2/ / 4 alpha.

- For a typical polymer at room temperature (see original). Thus, on taking x=0.1 cm we get delta t much less than 2.5 s. For copper at low temperature alpha approximately 10 cm/2//S. On taking x=0.1 cm we need delta t much less than 25 ns. For copper at room temperature alpha approximately 1, thus for x=0.1 cm delta t much less than 2.5 ms.

- The important features described here are now reviewed. Pyroelectricity is used to measure thermal properties with a rapid, simple apparatus for detection of thermal properties of thin films, layers, and structures. It is adaptable to a wide variety of materials over a wide temperature range. The heat

source can be
laser, E-beam, flashlamp, ion beam, IR resistive heating of sample,
or any other means of applying a short burst of heat to the sample.
Unlike other thermal conductivity measuring schemes this one does not
require thermally small sensors. In fact, the pyroelectric sensor
can be quite massive compared to the sample.
A variety of
pyroelectric materials are available including but not limited to PZT
(lead-zirconium-titanate) ceramics, LiTa0(3), TGS, and Rochelle salt.
The present technique is particularly suited to thin layers and
films, and it is fast and exceedingly easy, requiring no significant
sample preparation. The technique is easily adaptable to liquids or
viscoelastic materials, such as rubbers.
- Thermal properties of composites of various types can be
studied by this technique. In some cases the sample may not absorb
the available incident radiation (heat). In this case a thermally
thin absorbing layer 7 can be applied to the outer surface of the
sample (Fig. 3). In many cases the analysis of this case is even
simpler than that when the sample absorbs the radiation (heat)
itself. Here, layer 7 is the thermally thin absorbing layer. This
technique is suited for the investigation of time dependent materials
changes, such as chemical reactions or polymerization, as long as the
time scale of reaction t(R) is much greater than x/2/ /4 alpha that
the thermal transient is over before the material has changed.
- The technique is also a method of non-destructively measuring
the thickness of a material of known thermal diffusivity. In this

technique the pyroelectric sensor is not simply a temperature sensor.

In spite of the similarity of the data (Fig. 1) to the solution to the thermal diffusion equation as described above, the voltage detected is not simply related to the temperature, i.e., the pyroelectric sensor is not a linear thermometer. In some cases it may be desirable to measure the frequency dependent voltage V(omega) as the modulation frequency omega is varied. The comparison then leads to values for the thermal properties of the sample. It should be clear that samples which are both highly absorbing and do not absorb heat may be studied with this technique.

- By choosing the types of heat input carefully it is possible to study very thick samples. For example, a 10.6 Mum laser pulse may be used to study silicon circuits because light is transmitted through the substrate and absorbed in the regions of metallization and circuit detail, causing heating only there. Thus putting this surface against a PZT crystal 3 will give a measure of the film(s) thermal behavior even though the sample is thick. This situation is sketched in Fig. 4, which shows a thick sample with a substrate 2 transparent to incident light.

- It should be clear that this technique provides a simple and reliable technique for measuring the thermal contact between two materials of known thermal properties. Therefore, the thermal contact between a thermal piston and a silicon chip could be determined in this way.

- This technique is particularly suitable for composite materials (e.g., epoxy, fiberglass) for which the thermal

properties can be
anisotropic.
Reference
(*) Y. S. Touloukian, C. Y. Ho and M. C. Nicolaou,"
Thermal Diffusivity, Thermophysical Properties of 1973.

FIG. 1A

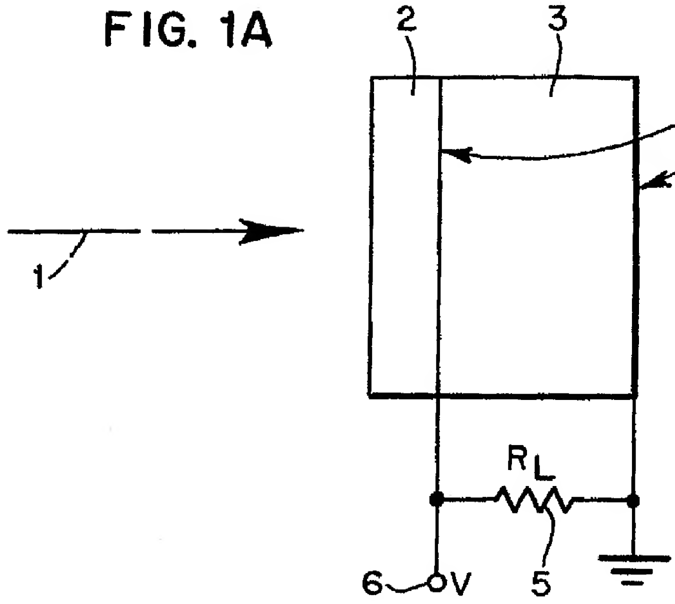


FIG. 1B

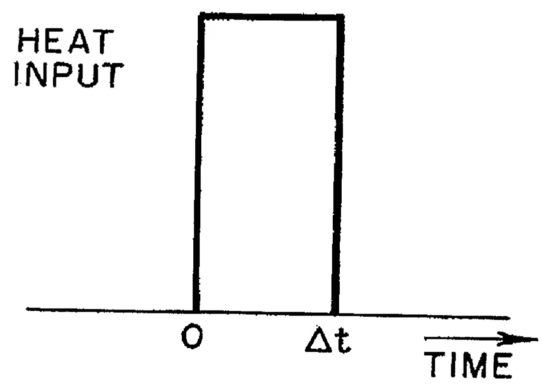
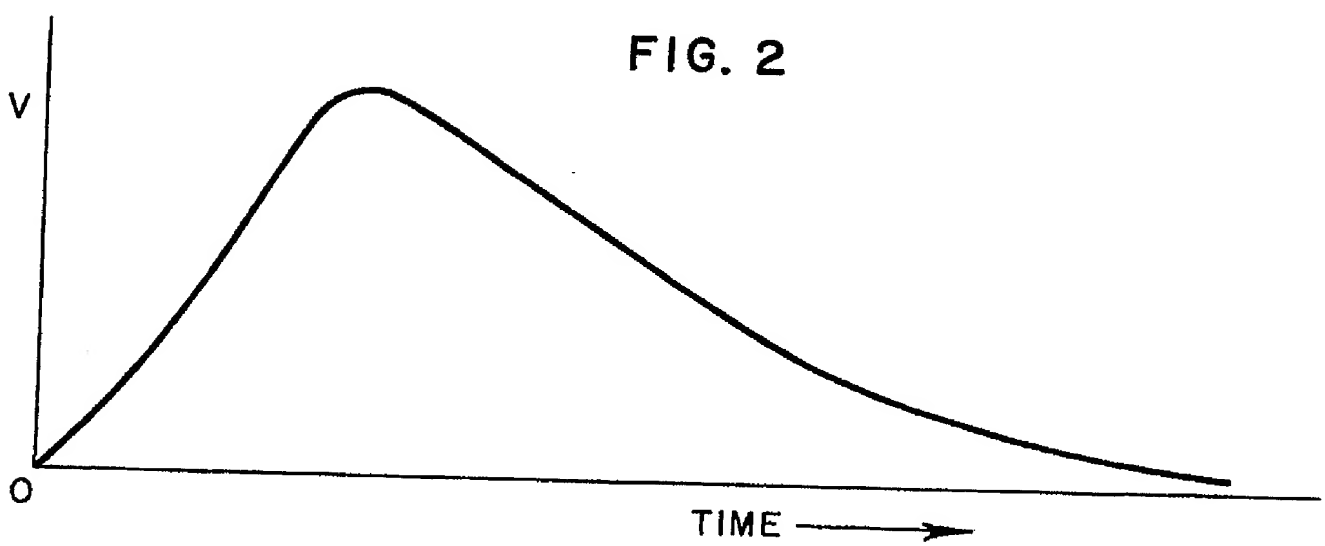


FIG. 2



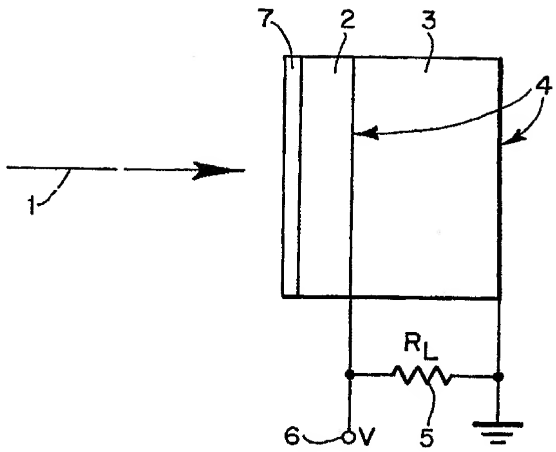
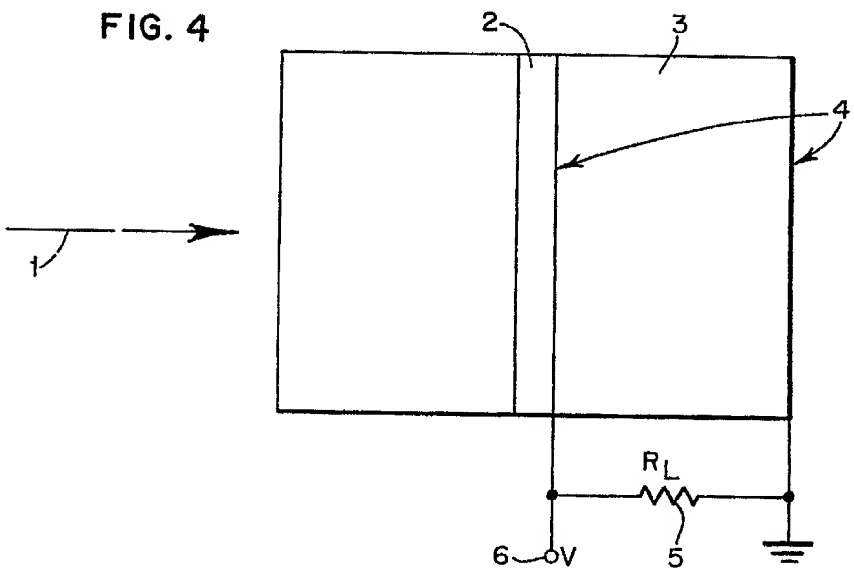


FIG. 3

$$T(x,t)=\frac{A}{t^{1/2}}e^{\frac{-x^2}{4\alpha t}} \qquad A=\text{const.}$$

FIG. 4



$$V(\omega)=-\left(\frac{1}{1+i\omega\tau_0}\right)i\omega AR_L p\left(\frac{\tanh Gl}{Gl}\right)r\frac{B}{G_S}\left(\frac{I}{B^2-G_S{}^2}\right)\frac{1}{\cosh G_S d}\cdot\frac{[1-e^{-Bd}(\cosh G_S d+\frac{G_S}{B}\sinh G_S d)]}{[r\tanh G_S d+\tanh Gl]}$$

	Type	L #	Hits	Search Text	DBs	Time Stamp	Comments
1	BRS	L1	77	pyroelectric same power adj1 supply	USPAT	2003/03/11 14:32	
2	BRS	L2	10	pyroelectric same integrated adj1 circuit same heat$3	USPAT	2003/03/11 14:22	
3	BRS	L3	9	pyroelectric same integrated adj1 circuit same heat$3	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/03/11 14:22	
4	BRS	L4	79	pyroelectric same power adj1 supply	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/03/11 14:42	
5	BRS	L5	2	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 power adj1 (source or supply)	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/03/11 14:45	
6	BRS	L6	1	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 power adj1 (source or supply)	USPAT	2003/03/11 14:51	
7	BRS	L7	1	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 electric$3 adj2 (energy or source or power)	USPAT	2003/03/11 14:50	

	Type	L #	Hits	Search Text	DBs	Time Stamp	Comments
8	BRS	L8	0	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 electric$3 adj2 (energy or source or power)	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/03/11 14:50	
9	BRS	L9	0	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 electric$3 adj2 (energy or source or power)	USOCR	2003/03/11 14:51	
10	BRS	L10	0	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 power adj1 (source or supply)	USOCR	2003/03/11 14:51	
11	BRS	L11	0	pyroelectric adj1 capacitor.ti.	USPAT	2003/03/11 14:52	
12	BRS	L12	19	pyroelectric adj1 capacitor	USPAT	2003/03/11 14:52	
13	BRS	L13	12	pyroelectric and capacitor.ti.	USPAT	2003/03/11 14:53	
14	BRS	L14	0	pyroelectric same capacitor.ti.	USPAT	2003/03/11 15:02	
15	BRS	L15	10	pyroelectric adj1 conver$4	USPAT	2003/03/11 15:06	
16	BRS	L16	9	pyroelectric adj1 conver$4	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/03/11 15:07	